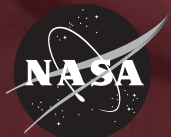


AEROSPACE TECHNOLOGY

innovation

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NASA: Inspiring the Next Generation of Explorers Through Education



WebTurbine Impacts Learning
NASA Reaching Visually Impaired
SEMAA Celebrates 10th Anniversary

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About the Cover:

NASA Administrator Sean O'Keefe speaks with students in Syracuse, NY. NASA Headquarters/Bill Ingalls.

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Commercial Development Mission Update

Shuttle launch schedule is currently under review.

Welcome to Innovation

Inspiration Through Education

By Adena Williams Loston, Ph.D.

Associate Administrator for Education

The cornerstone goal of NASA's new Education Enterprise is to inspire our next generation of explorers—the next wave of inventors, discoverers, technologists, scientists, mathematicians, engineers and educators.

For nearly 50 years, the men and women of NASA have broken barriers to open new horizons of opportunity. Our journeys in air, in space and on Earth have given us a new understanding of our universe, safer and faster air travel, and breakthroughs in health care and scientific research. We also have inspired humanity, young and old alike, to reach for new heights. While each of these achievements and the people behind them are unique, at their foundations they are linked by a common denominator—education. None of the accomplishments we herald in our nation's history, our daily lives or in our laboratories and research centers would have been possible without quality education and the people who help to open the minds of those who dare to explore and dream.

In his "Pioneering the Future" address on April 12, 2002, NASA Administrator Sean O'Keefe said, "Today, America has a serious shortage of young people entering the fields of mathematics and science. This critical part of NASA's mission is to inspire the next generation of explorers so that our work can go on. This educational mandate is an imperative."

NASA's call "to inspire the next generation of explorers" now resounds throughout the NASA community, as well as in colleges, universities, schools, museums, science centers, community centers and planetariums around the country. The goal is to capture student interest, nurture their natural curiosities and intrigue their minds with new and exciting scientific research. The Agency also is determined to provide educators with the creative tools they need to improve America's scientific literacy.


The future of NASA begins with America's youngest scholars. According to Administrator O'Keefe, if NASA does not motivate the youngest generation now, "there is little prospect this generation will choose to pursue scientific disciplines later."

Since embracing Administrator O'Keefe's educational mandate over a year ago, the NASA family has been fully devoted to broadening the Agency's roadmap to motivating our nation's future workforce. Our efforts have generated a whole new showcase of thought-provoking learning opportunities that are fun and that reach out to young people, educators and families through printed material, Web sites and Webcasts, robotics, rocketry and aerospace design contests, and various other activities.

Educators create horizons of opportunity in classrooms every day. They prepare, inspire, excite and encourage future generations of explorers to ask new questions and to seek answers. Educators are the adventurers in our midst, and without them our journeys would not succeed. As we move into our second century of flight, we must work with all who touch the future to help prepare a new generation of Americans to meet the growing challenges in science, technology, engineering and mathematics.

To meet this challenge, NASA has established the Education Enterprise. Working collaboratively with NASA's scientific and technical Enterprises, the Education Enterprise will ensure that education is an integral component of every major NASA research and development mission. This Enterprise will provide unique teaching and learning experiences, "as only NASA can," through the Agency's research and flight capabilities. Students and educators will work with NASA and university researchers and scientists to use authentic data to study the Earth, explore the universe and conduct scientific investigations in the fields of aerospace and space-based research.

As we celebrate the accomplishments of the nation's first 100 years of flight, we look forward with great anticipation to the next century of flight. The next generation of explorers—the explorers of the new millennium—must fully represent this nation's rich and vibrant diversity. NASA's Education Enterprise will strive to ensure that all children can explore their full potential as Americans. In doing so, the Agency will fully engage underrepresented and underserved communities of students, educators and researchers. Furthermore, we will support our nation's universities, colleges and community colleges by providing exciting research and internship opportunities that fuel the passion of young people, creating a culture of learning and achievement in science, technology, engineering and mathematics.

Welcome to NASA's Education Enterprise. Working together, we can "see learning in a whole new light." 

Reaching the Stars Through Education

As NASA celebrates its 45th anniversary this year, the Agency also celebrates nearly 45 years of dedication to education. With the designation of Education as NASA's newest Enterprise in 2002, the focus on the next generation has become even more of a core element of the organization and is now an integral component of every major NASA research and development mission. NASA's call "to inspire the next generation of explorers" is resounding throughout the NASA community, schools and informal education venues across the country. As a result, NASA has begun to unify the educational programs throughout NASA Headquarters, the Agency's other five science and technology Enterprises, and the Agency's 10 Field Centers under the "One NASA" education vision. The Education Enterprise's programs are inclusive of everyone and have a special focus on traditionally underrepresented groups in an effort to ensure that the next generation of explorers will represent the full diversity of the US population.

NASA wants to capture the interests of students and intrigue them with new and exciting scientific research. The Agency also is providing educators with the tools they need to improve America's scientific literacy. A number of learning opportunities have been generated through printed material, Web sites and Webcasts, robotics, rocketry and aerospace design contests, just to name a few. In 2002 alone, NASA reached well over a half million educators, nearly two million K-12 students and almost 70,000 higher education students through direct, onsite activities and programs. In addition to those served by broad-based NASA education programs, the Agency also reached more than 17,000 minority students through its minority-targeted academies, scholarships and other initiatives.

Leveraging the fascination that children have with flying vehicles, NASA designed the educational initiative "Robin Whirlybird on Her Rotorcraft Adventures." This online, Web-based interactive children's book introduces K-4th graders to the history, concepts and research behind aeronautics and rotorcraft. "The Adventures of Amelia the Pigeon" is a similar effort developed last year. Through an interactive Web site, this project teaches children how scientists use satellite imagery to better understand the Earth's environmental changes.

NASA also is impacting traditional textbook learning. Earlier this year, the Agency joined forces with Pearson

Scott Foresman, the leading pre-K-6 educational publisher, to collaborate on the development of a new science textbook series. Before the new series is published, lessons will be designed for students and teachers following the steps that Barbara Morgan, NASA's first Educator Astronaut and a former elementary school teacher, will take in preparation for her flight into space.

NASA's focus on children with special needs has led to the development of a new astronomy program using Internet technology. The program opens up the universe to youngsters who would otherwise be denied the experience because of physical or cognitive challenges. The program is funded by NASA through the Space Telescope Science Institute (STScI) of Baltimore. Students with visual impairments are provided the opportunity to explore space through a new book, *Touch the Universe: A NASA Braille Book of Astronomy*. The book incorporates Braille and large-print descriptions of each of its 14 photographs to make it useful and intriguing for readers.

The NASA Explorer Schools (NES) program is a new Education Enterprise initiative designed to provide customized, extended professional development for educators and unique science and technology experiences for students, their families and communities. NES will link participating schools with NASA personnel and other partners in a three-year partnership to develop and implement action plans for educators. The action plans will promote and support the use of NASA materials and programs that address local needs in mathematics, science and technology education. Each team consists of three or four science, mathematics or technology teachers, an administrator and a state supervisor, who begin the partnership with an all-expense-paid week of intensive training at one of NASA's 10 Centers. Each NES team receives a \$10,000 grant intended to assist with the purchase of science and technology tools to support implementation plans and to bring cutting-edge educational technology to the classroom.

About 18,000 South Carolina educators representing a half-million students are registered users of three Emmy Award-winning shows developed at NASA Langley Research Center Office of Education. *NASA Science Files* and *NASA Connect* are aimed at students ranging from grades three through 12. The third show, *NASA's Destination Tomorrow* is designed for educators, parents and life-long learners. NASA Webcasts are reaching schools across America as a valuable distance-learning

tool. Students are able to learn how NASA studies the Northern Lights phenomena to improve satellite operations and space communications. They can study the role of snow cover on the Earth's water and climate, and conduct science and engineering experiments based on those of the actual Mars Exploration Rover mission.

Giving distance learning a new meaning, the ISS EarthKAM (Earth Knowledge Acquired by Middle school students) allows youngsters to take pictures of Earth using a camera on the International Space Station (ISS). Students can control the high-resolution digital camera operating on the space station's Destiny science module through special Internet connections. The project, created in 1994 by Dr. Sally Ride—America's first female astronaut—is helping scientists at NASA Goddard Space Flight Center study the planet's changing surface.

As NASA's role in education grows, the Agency is forming partnerships that will provide support and encouragement for youngsters who may be at a disadvantage. Career Opportunities for Students with Disabilities (COSD) and NASA have joined forces to encourage students with disabilities who are pursuing mathematics, science, engineering and technology degrees to seek employment with the Agency.

NASA also supports underrepresented students by providing outreach and assistance to Historically Black Colleges and Universities, Hispanic-Serving Institutions and Tribal Colleges and Universities, and

encouraging recruitment, development and academic growth opportunities. As an example, on October 23, 2003, NASA presented a first-time grant of \$500,000 to the Hispanic College Fund to assist some of the nation's best and brightest students entering careers in science, technology, engineering and mathematics.

In another initiative, NASA helped launch a new education center to inspire and support socially and economically disadvantaged students in their quest for higher learning. The NASA Center for Success in Math and Science is located on the campus of Estrella Mountain Community College in Avondale, AZ. Through the center, NASA will provide educators with resources to foster learning opportunities and educational excellence, encourage family involvement and establish links with businesses and groups in the community.

Meanwhile, 340 high-achieving students representing nearly every state in the nation and the US territories of Puerto Rico and St. Croix participated in NASA's Summer High School Apprenticeship Research Program (SHARP). In June 2003, SHARP participants became apprentices to scientists and engineers at NASA Centers and universities around the country. NASA SHARP is a research-based program that focuses on NASA's mission, facilities, human resources and programs. The effort advances the Agency's goals of involving underrepresented students in academic, workplace and social experiences.

In another partnership, NASA and the Foothill-De Anza Community College District will facilitate the



Mr. O'Keefe with a group of students at the National Air and Space Museum in Washington, DC. NASA Headquarters/Renee Bouchard.

development of an academic center in NASA Research Park at Ames Research Center. The academic center will be for first-generation college students interested in science, technology and engineering. This agreement will give community college students access to classrooms and laboratories at NASA Ames.

During NASA Amusement Park Physics Days, the Agency engages in many activities in microgravity at Cedar Point in Sandusky, OH, and Six Flags World of Adventure in Aurora, OH. NASA scientists, engineers and educators volunteer in a variety of ways at the parks for this event. In 2003, a total of 14 multimedia presentations were given to approximately 2,700 participants inside theaters at Cedar Point and Six Flags. NASA character Microgravity Man and his assistants engaged more than 1,500 student, teacher and adult visitors in demonstrations. More than 800 teachers and students attended talks given by astronaut Leland Melvin at special presentations on May 21 at Six Flags and May 22 at Cedar Point.

In recognition of the 100th anniversary of the Wright brothers' historic first flight, NASA conducted a "Centennial of Flight National Tour," offering NASA exhibits at air shows, expositions and fairs throughout the country. A centerpiece of the NASA exhibit has been the Aerospace Technology Education Booth, which has featured a wide range of information for educators and students. The tour has reached more than 7.3 million students, educators and families. The tour culminates at the First Flight Celebration in Kitty Hawk, NC, December 12–17, exactly 100 years after the first flight of a powered, controlled aircraft.

As students prepare to visit a NASA Field Center, their teachers are becoming members of the permanent Astronaut Corps. NASA received more than 8,800 teacher nominations during the three-month recruit-

ment phase, and the Educator Astronaut Program Office received more than 1,600 applications. NASA plans to review the applications and select Educator Astronaut candidates to begin training at NASA Johnson Space Center in 2004. Upon completion of training, Educator Astronauts will be eligible for space shuttle flights as Mission Specialists. These teachers will help NASA link classrooms on the ground directly to the research and science under way in orbit.

Through NASA's Earth crew, now more than 40,000 members strong, teachers as well as parents and students, who may not have the opportunity to board a space shuttle, can pursue activities that enable them to interact with astronauts, scientists and engineers in projects and missions. Earth crew mission activities are Web-based and are accessible through NASA's Educator Astronaut Web site at <http://edspace.nasa.gov>

Finally, in an effort to attract and maintain a workforce that captures the full potential of this nation's diversity, and to address the national need for a new generation of people skilled in science, technology, engineering and mathematics, NASA has recently created the Corporate Recruitment Initiative (CRI). NASA has initiated a five-year plan for the CRI, a joint effort of NASA's Education Enterprise, Office of Human Resources and Office of Equal Opportunity Programs, which includes recruitment campus visits nationwide by teams of NASA officials.

From mid-September through mid-November 2003, teams of NASA representatives, including NASA Administrator Sean O'Keefe, Deputy Administrator Frederick D. Gregory and Associate Deputy Administrator for Institutions and Asset Management James Jennings, have met with countless students from nearly 40 institutions during on-campus NASA Awareness Days.

From walking on the moon to examining distant planets using new technologies, NASA has led some of the most unique missions ever imagined and has worked to share its discoveries and adventures with the nation's students, educators and families along the way. NASA-sponsored education programs open the door for students from all walks of life and encourage them to pursue their interests in science, mathematics, engineering and technology. NASA continues to develop educational programs incorporating Agency-related research and innovations as an essential undertaking, with an eye toward inspiring the next generation of explorers . . . as only NASA can. □

For more information, visit <http://www.nasa.gov> and <http://www.hq.nasa.gov>
Please mention you read about it in **Innovation**.



Inquisitive students ask Mr. O'Keefe questions at the National Air and Space Museum. NASA Headquarters/Renee Bouchard.

NASA Honors Agency Development

NASA selected a data analysis system for an Earth-observing satellite instrument and a software program used on the International Space Station and space shuttle as winners of the Agency's 2003 Software of the Year Awards.

The data analysis system is for the orbiting Sea-viewing WideField-of-View Sensor (SeaWiFS) instrument. It makes the data collected about oceans and climate available to thousands of scientists around the world over the Internet. It also provides the necessary tools to break down and analyze the data in a consistent, scientific manner, as well as ensures the data downlinked from the instrument are of the highest quality. The SeaWiFS Data Analysis System (SeaDAS) is used at more than 500 sites in 50 countries. The SeaDAS team leader is Gene C. Feldman of NASA Goddard Space Flight Center, Greenbelt, MD.

The SeaWiFS project is funded by NASA's Earth Science Enterprise, a long-term, coordinated research effort to study the Earth as a global system. Using the unique perspective available from space, NASA is observing, monitoring and assessing large-scale envi-

ronmental processes, such as the oceans' productivity, focusing on climate change.

The other winning software is NASGRO[®], an internationally accepted standard code for fracture control analysis of space hardware. It is a classic engineering software design and analysis tool that was developed over a number of years. It was distributed to virtually every design firm in the world that must deal with metallic structures.

At NASA, the code has important use in the space shuttle and space station programs, including analysis of payloads and resolution of crack-like anomalies. NASGRO is used in numerous other industries and by other government agencies. It is receiving significant support from the Federal Aviation Administration for the development of improved capabilities for damage tolerance analysis of aircraft.

The NASGRO team leader is Royce Forman of NASA Johnson Space Center, Houston, TX. □

For more information, contact Michael Braukus, Office of Public Affairs, NASA Headquarters, ☎ 202/358-1979. Please mention you read about it in **Innovation**.

NorTech Awards NASA Technologies

Two diverse technologies—one that demonstrates Internet connectivity between moving vehicles and the other a high-temperature thermal barrier/seal—were recently awarded a 2003 NorTech Innovation Award.

The innovative technologies were developed at NASA Glenn Research Center (GRC), Cleveland, OH.

Mobile Internet Protocol Router technology was developed in partnership with Cisco Systems and Western Datacom. The new technology possesses the ability to communicate through an encrypted, mobile network allowing instantaneous and continuous Internet connectivity. The mobile networking technology will make space communications in low-Earth-orbiting research vehicles as easy as we now have Internet access here on Earth. Other than NASA's use for space communications and orbiting spacecraft, the technology also could be used by the military for keeping troops in the field informed or for emergency

management services, railroad and shipping systems, the automotive industry and travelers.

GRC employees Will Ivancic, Satellite Networks and Architectures Branch, and Phil Paulsen, Project Management Branch of the Space Communications Office, worked with a team of engineers from five other companies in the development of the mobile networking technology.

A high-temperature thermal barrier/seal was developed to prevent hot gases from reaching temperature-sensitive nozzle O-rings in solid rocket motors for heavy-lift space launch vehicles, including the space shuttle. The new braided carbon-fiber thermal barrier is capable of reducing the temperature of the 5,500 degree F rocket combustion gas to permit only relatively cool (<200 degree F) gas to reach the O-rings. This new technology also enables the solid rocket motor nozzle joints to be assembled in one-sixth

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Leaders Discuss Nanotechnology Market

To discuss the trillion-dollar nanotechnology market that experts believe will be born from research at the molecular scale, almost 300 leaders, from industry, academia and government, converged on August 19 at NASA Ames Research Center in California's Silicon Valley. NASA co-hosted the Bay Area Nanotechnology Forum with US Representative Mike Honda, co-sponsor of the Boehlert-Honda Nanotechnology Bill, H.R. 766.

The President's Administration strongly endorses this initiative. As reported in the National Nanotechnology Initiative: Supplement to the President's FY 2004 Budget, "Investments in nanoscale science and technology R&D are essential to achieving the President's top three priorities: winning the war on terrorism, securing the homeland and strengthening the economy" (Marburger).

"Though nanotechnology has its roots in the 20th century, this exciting discipline will come to maturity during this century and will revolutionize our way of life more than any other technology preceding it," said NASA Ames Center Director G. Scott Hubbard. "Those of us who come together here today realize that the R&D community is on the verge of significant scientific discovery and soon will help bring the nanotechnology revolution front and center in the lives of all who inhabit this planet."

Nanotechnology is the creation of materials, devices and systems through the control of matter on the nanometer scale. A nanometer is one-billionth of a meter. Scientists say nanotechnology could lead to changes in almost everything from computers and medicine to even automobiles and spacecraft.

"Nanotech represents the 'next best thing' to come after the great high-tech boom that is the basis of our regional economy, and it is important that we do all that we can to ensure that as the field grows, the bay area shares in that growth," Honda said. "A visit to NASA Ames in early 2002 was when I first became very excited about the potential of this new technology and began to focus on both the funding and policy issues related to nanotechnology," Honda explained.

US Representative Zoe Lofgren, a co-sponsor of H.R. 766, said that the local economic situation is "grim in this area where one-third of households have experienced layoffs" in recent years. She said that she and Honda have seen the Silicon Valley transform into a high-technology center because of investments. The National Science Foundation (NSF) predicted that the worldwide market for nanotechnology products and services could reach \$1 trillion by 2015, according to Honda.

"Just as computers have transformed the way our society operates over the last 30 years, nanotechnology stands ready to transform our future," said US Rep. Anna G. Eshoo in a statement read to the crowd by Hubbard.

"As part of our pursuit of NASA aeronautics and space programs, NASA Ames is working to fuse information technology, biotechnology and nanotechnology R&D," Hubbard explained. "This will facilitate NASA's ability to achieve the nation's goals in aeronautics and space. We can reduce the cost of space exploration, bring back better information and help determine whether there is life beyond our planet," Hubbard said.

"NASA's interest in nanotechnology is that it will result in stronger materials, ultra-small electronic devices, perhaps even intelligent spacecraft. Miniaturization also may well enable new space missions with lower weight parts requiring less power and fuel," Hubbard said.

"We are now waiting for the Senate to act on its own nanotechnology bill, which differs slightly in its details from the House bill," Honda said. "President Bush has expressed his support, however, so I expect the bill to come to the Senate floor for approval when we return this fall, a compromise to be worked out, and the bill to be signed by the President," Honda explained. "The largest chunks of the funding in the bill will either be directed to programmatic efforts of the agencies, to centers and projects at the national labs run by the Department of Energy and facilities such as NASA's nanotechnology center here at Ames, or be distributed through peer-reviewed grant competitions (NSF), which academic researchers are quite familiar with," Honda said.

"Some nanotechnology advances that scientists expect will benefit NASA include integrated nanosensors that will collect, process and communicate massive amounts of data," said Meyya Meyyappan, the Director of the Center for Nanotechnology at Ames, who presented a major talk during the forum. Nanotechnology will impact computing and data storage, materials and manufacturing, health and medicine, energy and environment, transportation, national security and space exploration, according to Meyyappan. □

More information about NASA nanotechnology can be found on the Web at <http://www.ipt.arc.nasa.gov>. Additional information about the forum and some presentation notes are available on the Internet at www.bayareananoforum.org. Please mention you read about it in **Innovation**.

Commercial Firm To Enhance Software

The University of Maryland (UMD) announced in early July 2003 the exclusive licensing of the NASA-sponsored Quantitative Risk Assessment System (QRAS) to Item Software, Inc., of Anaheim, CA. The license agreement enables the commercial enhancement of this innovative Probabilistic Risk Assessment software system for a worldwide market, as well as NASA mission programs.

NASA's Office of Safety and Mission Assurance began the development of QRAS in 1996. Jointly developed with researchers at the UMD, QRAS software automatically expands the reliability logic models of systems to evaluate the probability of highly detrimental outcomes occurring in complex systems that are subject to potential accident scenarios. The software is designed for managers and design engineers with minimal, specialized training. Following the delivery of the latest version of the QRAS software in January 2003, the UMD and NASA continued their collaboration by working to license QRAS for commercial development and sale.

Item Software (<http://www.itemsoft.com>), established in 1986, offers software solutions, along with consulting and training services, for reliability, availability, maintainability, safety, quality assurance and risk assessment to government and commercial customers in aerospace and other industries. The company plans to build on the state-of-the-art features of QRAS, preparing the software for commercial sale as part of its suite of software and associated services. Item Software will handle distribution, support and training for the software.

In addition to bolstering the technological capabilities of Item Software and transitioning QRAS for commercial use, the company's market-driven enhancement of the QRAS software is expected to improve its utility for NASA mission programs. □

For more information, contact Kamran Nouri, CEO of Item Software, Inc., ☎ 714/935-2900, itemusa@itemsoft.com, or Jonathan Root ✉ jonathan.root@nasa.gov at NASA Headquarters. Please mention you read about it in **Innovation**.



(L-R) Kamran Nouri, ITEM Software President; Dr. Ali Mosleh, University of Maryland; Kamyar Nouri, ITEM Software Executive Vice President; Dr. Frank Groen, University of Maryland; Dr. Michael Stamatelatos, NASA Headquarters; and Dr. Akash Gupta, ITEM Software. NASA Headquarters.

NorTech

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of the time of previous approaches. In addition to playing an important role in the nation's space program, potential industrial applications for the new thermal barrier/seal include sealing furnace doors to prevent escape of super-heated gases and sealing processing equipment in the chemical industry.

Bruce M. Steinetz and Pat Dunlap, both in the Mechanical Components Branch at GRC, developed the new high-temperature thermal barrier/seal.

NorTech Innovation Awards, formerly known as the EDI Innovation Awards, are named for the Northeast

Ohio Technology Coalition (NorTech), the technology affiliate of Cleveland Tomorrow. The awards honor innovators and companies for creating some of the best new products in Northeast Ohio.

The awards program is sponsored by Key Bank, Ernst & Young, Squire Sanders & Dempsey LLP, the Ohio Department of Development, Case Western Reserve University's Weatherhead School of Management and its subsidiary Enterprise Development, Inc. □

For more information, contact Laurel Stauber at ☎ 216/433-2820, ✉ laurel.j.stauber@lerc.nasa.gov. Please mention you read about it in **Innovation**.

HHT Revolutionizes Signal Analysis

Since 1965, scientists have used Fast Fourier Transform (FFT) to analyze periodic signals generated by mechanical systems. However, when natural/physical phenomena are involved—from heartbeats to acoustic and earthquake vibrations to waves and sea-surface temperatures—FFT falls short, unable to analyze accurately the chaotic and transient signals.

In the mid-1990s, NASA Goddard Space Flight Center innovator Dr. Norden Huang began developing a better method for analyzing data for NASA's Earth Science Enterprise. Dr. Huang's new algorithms, which combined the empirical mode decomposition method with the Hilbert transform method, accurately analyzed the time, frequency and energy data of physical signals. These algorithms—officially called the Computer Implemented Empirical Mode Decomposition Method, but better known as the Hilbert-Huang Transform (HHT)—revolutionized signal processing.

The HHT technology is a highly efficient, adaptive and user-friendly general computational method for analyzing data from physical signals. HHT offers improved accuracy and yields more meaningful results than with previous analysis tools, which tended to obscure or discard valuable information. The method can be used to conduct spectrum analysis of any physical signal—signals that, by their very nature, are nonlinear and nonstationary. Such signals are found in communications, sonar, seismic analysis, acoustics, optics and other applications.

By transforming the nonlinear and nonstationary signals into accurate frequency information, HHT opens up a whole new world of understanding—a world that previously was inaccessible via standard methods. Applications can be found in medicine—sensors, imaging, drug discovery and instruments; acoustics/vibration—analysis of highway noise, speech/sound and machine vibration; and industry—machine monitoring/failure prediction and electrical circuits. HHT also can be used to perform numerical simulation of fluid flow, nondestructive testing and shock loading of structures, environmental analysis and even analysis of economic and market data.

The revolutionary HHT method has been recognized as “one of the most important discoveries in the field of applied mathematics in NASA history,” as stated by NASA's Inventions and Contributions Board in bestowing the technology and Dr. Huang with an

The revolutionary HHT method has been recognized as “one of the most important discoveries in the field of applied mathematics in NASA history.”

Exceptional Space Act Award. HHT also won the 2002 NASA Government Invention of the Year Award. The technology has received recognition from the Federal Laboratory Consortium—2001 Award for Excellence in Technology Transfer; *R&D Magazine*—2001 R&D 100 Award; and *Government Executive Magazine*—1999 Government Technology Leadership Award.

HHT is now on the fast track to commercial use. In addition to its use in other NASA programs and projects, the HHT algorithms and the software program that implements them are available outside of NASA. Qualified users can download a 60-day trial version for testing and evaluation. Upon seeing how successfully HHT performs, users can license the software for ongoing use.

Early responses to HHT have been extremely favorable, and NASA Goddard Space Flight Center expects many more potential users to register their interest. So far, the HHT trial software has been distributed to more than a dozen government agencies, universities and commercial companies for testing and use in a wide range of applications, including acoustical data analysis, nondestructive evaluation and medical data analysis.

The future for HHT in the commercial marketplace looks even brighter in the coming months. This fall, HHT will be featured at the 2003 National Association of Seed and Venture Funds conference, held November 2–5 at the Wyndham Inner Harbor Hotel in Baltimore, MD. In keeping with the conference theme of “Innovations in Early Stage Investing,” HHT will be presented and discussed during a panel focusing on investing in platform technologies. (See <http://www.nasvf.org> for more information on the conference.) □

More information on HHT, its benefits, its applications and how to license it is available at <http://techtransfer.gsfc.nasa.gov/HHT/HHT.htm>. Please mention you read about it in **Innovation**.

Classroom of the Future Impacts Learning

The NASA Classroom of the Future (COTF) program is helping to bridge the gap between America's classrooms and the expertise of NASA scientists, who have advanced the frontiers of knowledge in virtually every field of science over the last 40 years.

The COTF engages students in "real science" by presenting them with actual problems currently under investigation in various science disciplines. In attempting to solve these problems, students may access the same datasets used by practicing researchers. The COTF program is administered by the Center for Educational Technologies at Wheeling Jesuit University in Wheeling, WV.

One of the newest COTF exercises is putting students in the role of meteorologists. The COTF has created STORM-E—a distance-learning (education conducted using video, audio and/or computer, which does not require the physical presence of instructors or students) weather-simulation tool targeting grades four through eight. It asks young people, "Can you predict the weather?"

STORM-E (Students and Teachers Observing and Recording Meteorological Events) is designed to culmi-

nate any classroom weather unit. Jane Neuenschwander, NASA Educator Resource Center Coordinator and Curriculum Designer at the COTF, explained that air pressure, humidity, temperature and winds are the four areas used to organize this simulation. Each student joins a team and focuses on data from one of those areas. The teams are then asked to help with the decision of holding or canceling the outdoor events based on maps, graphs, data and satellite images provided. The simulations are based on historic weather events. The students connect to Neuenschwander at the COTF via distance-learning technology.

"Today's students need opportunities to be problem solvers," says Neuenschwander. "The simulation requires students to tackle a problem using the science-processing skills of observing, inferring, predicting, communicating and interpreting data. These same skills are needed to succeed on current proficiency tests, and that excites teachers."

STORM-E was designed as a curriculum option for the NASA Explorer Schools. However, it is available to all schools with videoconferencing capabilities.

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Jane Neuenschwander showcases materials from STORM-E, one of the newest NASA Classroom of the Future exercises. NASA Headquarters.

NASA Reaching Visually Impaired

NASA stretches the limits when it comes to education, reaching students and teachers with vision disabilities, helping them to learn and teach about the exciting realms of math, science and robotics through their very own cyberspace classroom. The Learning Technologies team at NASA Johnson Space Center, Houston, is building an array of e-tools for blind or low-vision students, educators and professionals.

The Information Accessibility Lab (IAL) is a software platform that will provide an alternative way to access NASA math and science content, which would otherwise require graphical display—unseen by the visually impaired. Although IAL was originally conceived as a tool for the blind, it offers a unique way for all students to tackle the crucial concepts of spatial visualization, which underlie ideas in mathematics and science.

The IAL technology was developed over the last year to support the NASA-wide Learning Technology Project, an effort under the NASA Education Enterprise Technology and Products Organization headed by Dr. Shelley Canright. The purpose of the technology is to provide alternate access to spatial/graphical content for students with vision or spatial perception problems.

While hand-generated descriptions are great for situations in which the content is static, there are many situations such as simulations and real-time activities where interactive content is generated dynamically, and thus an automated tool is desirable. The NASA application is to enrich the educational resources offered by the Agency, as well as to encourage students who are blind and their educators to consider science, technology, engineering or mathematics careers.

The first prototype application currently under development is the Math Description Engine (MDE). Similar to the standard graphing calculator used by algebra and trigonometry students, the MDE enables precollege and college students to key in an equation to be graphed. However, unlike the graphing calculator, the MDE analyzes the equation and translates the graph results into a format that can be visualized through text and sound.

The MDE combines the standard method of solving and calculating mathematical problems to generate text or sound descriptions of common curves in a graph. Through sound descriptions, musical tones vary to illustrate the curves as they go up or come down.

“My hopes and goals are to be part of this broader movement that is now practical for people with all kinds of disabilities,” said co-inventor Robert Shelton.

The Texas State School for the Blind and Vision Impaired and the National Federation of the Blind both show keen interest in the capabilities the IAL delivers.

“My hopes and goals are to be part of this broader movement that is now practical for people with all kinds of disabilities,” said co-inventor Robert Shelton, NASA Learning Technologies Regional Center Project Manager. “We have a lot of the technology to make this happen, and I want to give children a chance.”

Shelton, who is completely blind and holds a doctorate in mathematics from Rice University in Houston, Texas, knows firsthand the challenges that lay before students in learning math and science while visually impaired.

Other Web-based tools have been developed to aid students and educators. “ROVer Ranch” transports students to the exciting world of robotics, enabling students to design, build and perform mission tasks, just like NASA robotic engineers do. “NASA Qwhiz” puts students to the test, quizzing them on the NASA mission. Students can play against the computer or interactively against other students. The Internet Information Library Access Device (ILIAD) equips teachers with a smart search engine that features an e-mail interface. Because the browser is text-based and not graphical, it has become increasingly popular among blind computer users. “The Intelligent Math Tutor” boosts precollege and college students’ math success. The Web-based and now CD-ROM series eliminates hefty costs of textbooks and provides all the necessary tools to learn mathematics by computer, including algebra and trigonometry. □

For more information, contact Robert Shelton at NASA Johnson Space Center, ✉ robert.o.shelton@nasa.gov. Please mention you read about it in **Innovation**.

Classroom

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Meanwhile, the NASA Classroom of the Future also is promoting the development of inquiry-based learning environments through the Virtual Design Center. Researchers at the COTF have developed the Virtual Design Center to provide researchers and designers with guidelines for educational technology design. The Virtual Design Center has two main goals: to serve as a NASA resource for stimulating development of research-based instructional technology and classroom activities for scientific inquiry; and to share new knowledge about how learning theories can be applied to instructional technology and classroom environments to promote scientific inquiry in K–12 students. The content of the Virtual Design Center consists of empirical

research, theories and examples of existing technology learning tools that facilitate scientific inquiry.

Within the Virtual Design Center framework, designers can participate in an online workshop to support the design of inquiry-based learning environments. The workshop is composed of six sessions that link current research practices to specific design principles. Participants receive feedback from workshop facilitators at each step in the process. The sessions cover the design of an investigation question, development assessment materials and design of support materials. Workshop participation is open to NASA-affiliated designers. □

For more information, visit <http://www2.cet.edu/weather> or <http://www.cotf.edu/vdc>. Please mention you read about it in **Innovation**.

NASA Educators Challenge Students

As five spacecraft from countries around this world rapidly approach Mars, NASA educators are challenging students to learn about the red planet and design creatures that could survive in the harsh Martian environment.

In October, NASA Quest at NASA Ames Research Center, located in California's Silicon Valley, launched the "Design-a-Martian Challenge." NASA Quest is an educational Web site dedicated to bringing the NASA experience to K–12 students. The seven-week challenge builds upon the growing excitement about the red planet, and provides students an opportunity to interact with NASA Mars experts and other students from around the world.

"The Design-a-Martian Challenge is a great opportunity to have students actively participate in one of the greatest scientific endeavors in recent history," said Donald James, Education Director at NASA Ames. "With the knowledge gained from the challenge, the students will be Mars experts within their families and classrooms when the twin Mars Exploration Rovers land on Mars at the beginning of 2004."

During the first few weeks of the challenge, students used NASA's Astro-Venture, a Web site that helps students understand what makes a planet habitable, to research the conditions needed by humans to survive on Earth so they can apply that knowledge to Mars. As the students gained a better understanding of the planet, they began designing creatures that could survive punishing sand storms, cold temperatures and the other harsh conditions on Mars.

During the challenge, students were able to interact with NASA scientists to talk about Mars, NASA's missions to the red planet and their Martian creature designs.

"As NASA scientists, we are always looking to encourage students to take an active interest in science and exploration," said Geoff Briggs, Scientific Director of NASA's Center for Mars Exploration. "The Design-a-Martian outreach program builds upon the interest generated by the recent close opposition (alignment) of Earth and Mars and upon the excitement of the up-coming Mars landings. It's a great way to spark students' interest."

Final Martian creature designs were due in late November. The Design-a-Martian Challenge will conclude with a Webcast on December 3. During the Webcast, NASA scientists will update the students with the latest on Mars research and the progress of the Mars Rovers, and provide final feedback on the students' Martian creature designs. □

For more information, contact Jonas Dino at Ames Research Center, ☎ 650/604-5612, ✉ jonas.dino@nasa.gov. Please mention you read about it in **Innovation**.

Astronauts Inspiring the Next Generation

NASA is impacting education as never before with the kick-off of the Educator Astronaut Program.

NASA is selecting K–12 educators to join NASA's Astronaut Corps. The Agency hopes the selected educators will become a direct connection to classrooms by sharing with their fellow educators and students the talents and disciplines necessary to make history, to break barriers and to explore frontiers. The Educator Astronaut Program is expected to generate renewed interest in science, technology, engineering and mathematics, and cultivate a new generation of scientists and engineers.

NASA used criteria developed by a Blue Ribbon Panel to identify the candidates qualified to proceed to the next phase of the selection process at NASA Johnson Space Center. The panel was comprised of a diverse group of educators from the K–12 education community. The Space Foundation, one of the world's leading nonprofit organizations supporting space activities and education, won a competitive bid to convene the Blue Ribbon Panel. The nine-member Blue Ribbon Panel met at the Space Foundation headquarters for an intensive five-week effort before submitting final criteria to NASA. The panel's goal was to establish an efficient and effective mechanism for selecting applicants, reviewing existing Educator Astronaut evaluative data, researching the literature on quality teachers and identifying selection criteria.

An Educator Astronaut is a fully qualified member of NASA's Astronaut Corps who has expertise in K–12 education. Educator Astronauts will perform the same activities that the current astronauts categorized as Mission Specialists perform on any space shuttle crew. Educator Astronauts will help coordinate space shuttle

crew activity planning and operations, assist with science experiments, participate in International Space Station assembly and operations, and perform other assigned Mission Specialists' duties. Mission Specialists perform extravehicular activities (EVAs, or spacewalks), operate the remote shuttle and/or space station manipulator arm, and are responsible for payloads and specific experiment operations.

NASA's objective is to build upon the selected Educator Astronauts and expand the education activities of previous missions. As educators, they have developed the skills necessary to communicate in the classroom the challenging concepts associated with the study of science, technology, engineering and mathematics. The merger of these two great American teams, our Nation's educators and astronauts, yields unparalleled opportunity for our nation, the education community and NASA to reach and inspire the very young people who will extend America's accomplishments and leadership far beyond our imagination.

Educator Astronauts will experience something unique every day that they can use to engage students and inspire them to consider a career associated with the nation's space program. NASA, as well as our numerous education partners, will work with each of the selected Educator Astronauts to make that connection in multiple and inspirational ways "to inspire the next generation of explorers . . . as only NASA can." □

For more information, please visit <http://edspace.nasa.gov>. For information about other NASA Education programs on the Internet, visit <http://education.nasa.gov>



Educator Astronaut Barbara Morgan shares her unique experiences to engage students and inspire them to consider a career associated with the space program. NASA Headquarters/Bill Ingalls, Renee Bouchard.

Neural Network Project Passes Milestone

NASA researchers have completed a milestone series of evaluation flights for a revolutionary flight-control system that could enable future aircraft suffering major system failures or combat damage to be flown to a safe, controlled landing.

The Intelligent Flight Control System (IFCS) research, aboard a highly modified NASA F-15B aircraft, focuses on the development of “self-learning” neural network software for aircraft flight-control computers. In its final form, the software would compare data from how the aircraft and its systems are operating with a database of how it would normally operate and automatically adjust the flight controls to compensate for any damaged or inoperative control surfaces or systems.

The work was accomplished by a team of researchers at NASA Dryden Flight Research Center, Edwards, CA; NASA Ames Research Center, Moffett Field, CA; NASA Langley Research Center, Hampton, VA; Boeing Phantom Works, St. Louis, MO; and the Institute for Scientific Research (ISR) in Fairmont, WV.

The IFCS project team successfully met research objectives by evaluating in flight a passive online Para-



Highly modified NASA F-15B aircraft. Dryden Flight Research Center.

meter Identification (PID) algorithm, or software code, and an online learning Dynamic Cell Structure (DCS) neural network algorithm.

This is a significant step for real-time PID and neural net technology, and serves as a significant proof of technology for the project’s direct adaptive (Generation I) flight control concept.

“This work marks a significant step toward learning, thinking aircraft that will be safer, more autonomous

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SEMAA Celebrates 10 Years

Over the last 10 years, an innovative program managed by the Office of Educational Programs at NASA Glenn Research Center, Cleveland, OH, has been inspiring a diverse student population, K–12, to pursue careers in the fields of science, engineering, mathematics and technology.

The 10th anniversary celebration of SEMAA (Science, Engineering, Mathematics and Aerospace Academy) coincided with the annual National SEMAA Conference, held June 16–19 in Cleveland, OH. Educators, students, parents and administrators from all 19 SEMAA sites across the country attended. The focus of the conference was to develop additional ways to create awareness and access to programs with similar purposes, and to develop partnerships.

SEMAA was born in 1993 of then US Congressman Louis Stokes’ concern about the low level of academic achievement of the young students in his district and his urging for the creation of a unique program that would focus on mathematics and science. Educational personnel at Glenn and Tri-C embraced his idea and developed the SEMAA program. □



A SEMAA student from Cleveland, OH prepares to conduct an icing research experiment in the FLOTEK 360 Wind Tunnel. NASA Glenn Research Center.

Further information about SEMAA can be found at <http://www.semaa.net>. Please mention you read about it in **Innovation**.

Scientists Test Wake Sounds

Tests in Denver will help scientists determine if sound can be used to detect, track and predict hazards from aircraft wake turbulence.

NASA's safety mission goal is to "enable safer, more secure, efficient and environmentally friendly air transportation systems." NASA's role in carrying out this goal is to "understand the challenges and develop the long-term, cutting-edge and leap-ahead technological solutions" (NASA 2003 Strategic Plan; 14–15).

In keeping with this mission goal, researchers, including a few from NASA Langley Research Center (LaRC) in Hampton, VA, spent more than three weeks collecting acoustic data at Denver International Airport. They used precisely calibrated microphone arrays to measure sound generated by airplane wake vortices. Two laser radars (lidars) recorded the actual position, track and vortex strength, so scientists and engineers could look for subtle characteristics within the wake acoustic signal.

"The purpose of the test is to acquire the best data ever collected on the wake acoustic phenomena," said Wayne Bryant, LaRC Wake Vortex Projects Manager. "We hope to establish whether an acoustic-based wake vortex sensor is operationally feasible for the airport environment. One of the key items we will be looking for is a relationship between the recorded acoustic signal and the hazard the wake represents. Estimates of this hazard level will be provided by the lidar systems in our test," he said.

Aircraft produce wake vortices when they fly, much like two small horizontal tornadoes trailing behind the wing tips. Larger, heavier aircraft produce stronger wakes. Small aircraft following larger ones can

encounter a wake vortex, if they are too close. This turbulence can be severe enough to cause a plane to crash.

Wake vortex detectors, such as lidar or possibly a wake acoustic sensor, are envisioned as important parts of a wake vortex avoidance system. Such a system may be able to give pilots advance warning of the location and nature of hazardous wake turbulence.

The technology also could increase runway capacity, because air traffic controllers would have a better idea of where wakes are and how they decay. Controllers could use that information to efficiently separate aircraft.

The Denver test also provided an opportunity to evaluate recent modifications to a laser-based wake acoustic sensor being developed by Flight Safety Technologies and Lockheed-Martin. The Sensors for Characterizing Ring-eddy Atmospheric Turbulence Emanating Sound (SOCRATES) projects low-power laser beams across open space onto a reflector device, which reflects the beams back to a receiver. Developers say the system then measures the changes in the laser beams, which reveal the existence of sound.

Participants in the wake acoustics test included NASA; the Department of Transportation; Volpe National Transportation Systems Center; OptiNav/Microstar/Titan; Coherent Technologies, Inc.; MIT Lincoln Laboratories; United Airlines; Florida Atlantic University; Flight Safety Technologies; Lockheed-Martin; and the German Aerospace Research Center. ■

For more information, contact Michael Braukus, Office of Public Affairs, NASA Headquarters, ☎ 202/358-1979. Please mention you read about it in **Innovation**.

Neural

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and more reliable than ever before," says John Carter, Dryden's IFCS Project Manager.

The PID algorithm is an online function that determines the actual stability and control characteristics of the aircraft as it flies. When results from the PID algorithm differ from what is called the Pre-Trained Neural Network (PTNN), an update to the system is required.

The DCS provides the online learning of the system. It tracks the differences between the PTNN and PID, and provides an organized map of updates to the stability and control derivatives of the aircraft.

The DCS software was developed by NASA Ames

for Generation I application. The PID software was developed by ISR in conjunction with NASA Langley.

Included among important features of the DCS are long-term memory, critical for IFCS use, and the ability to be enlarged by the addition of nodes.

IFCS software evaluations performed by the F-15B aircraft included handling qualities maneuvers, envelope boundary maneuvers, control surface excitations for real-time PID to include pitch, roll and yaw doublets, and neural network performance. ■

For more information, contact Gray Creech, Dryden Flight Research Center, Public Affairs Office, ☎ 661/276-2662, ✉ gray.creech@dfrc.nasa.gov. Please mention you read about it in **Innovation**.

SBIR Protects from Radiation

Integrated circuits lie behind the operation of computers, science instruments, communication systems, cars and more in today's world. Unfortunately, many commercially available, integrated circuits are susceptible to failure in a space environment as a result of collisions from heavy ions or protons that are produced by cosmic rays and solar flares. Therefore, it has been necessary to redesign and manufacture integrated circuits that are radiation hardened for space missions. This not only has been expensive and time consuming, but has meant that the latest integrated circuit designs have not been available for space missions. Under a SBIR contract managed at NASA Jet Propulsion Laboratory, Maxwell Technologies demonstrated a new technology that can be incorporated into the manufacture of the integrated circuits that protects against radiation damage. This technology has made it possible to take advantage of advanced circuit designs and lowered the overall cost of integrated circuits for space missions.

Radiation causes different types of damage in commercial integrated circuits. For example, if a heavy ion or proton strikes a memory cell, the stored data could be destroyed. This single event upset can cause a fatal error unless the software program using this data is



Single event latch-up protected integrated circuits suitable for space applications. Jet Propulsion Laboratory.

able to detect the upset and recover. Another possibility is that the heavy ion or proton collision causes a "localized short," resulting in an increase in current consumption that exceeds the integrated circuit's limit. This effect is known as a single event latch-up, which often destroys the operation of the integrated circuit. As a result, this type of event would cause a computer failure or some other system failure that depended on the integrated circuit for operation.

Maxwell has a number of civilian and military customers that have purchased latch-up protected integrated circuits for their satellite missions. The latch-up protection technology provides significant cost savings over alternative methods of protecting the operation of the integrated circuit.

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The Numbers Tell the Tale

Congress created the Small Business Innovation Research (SBIR) program in 1983 to provide an additional source of innovative research and technology to meet federal agency mission needs, while focusing on small business. Within NASA, more than 600 products and services have been advanced based on SBIR technology, and it is estimated that NASA SBIR technology has generated at least \$2.28 billion of cumulative revenues in non-US government markets.

The STTR program, originally authorized in 1992, was designed to include universities in collaboration with small business in innovative research.

NASA's 2003 SBIR/STTR Program solicitation closed on September 9, 2003. The solicitation contained 120 SBIR subtopics and 13 STTR subtopics. The 2003 results are reflected below as compared to 2002 results, in parentheses.

- 1,332 firms registered in the NASA SBIR/STTR Proposal Submission Electronic Handbook (1,090).
- 2,677 SBIR proposals were submitted (2,238).
- 177 STTR proposals were submitted (45).

The review and recommendation process will culminate with selection announcements on November 21, 2003. To view NASA success stories in both SBIR and STTR, or for more information, check out www.sbir.nasa.gov and click on "Success Stories." □

For more information, contact Carl Ray, NASA Headquarters, ☎ 202/358-4562, ✉ carl.g.ray@nasa.gov. Please mention you read about it in **Innovation**.

Seeing into the Future?

It may sound strange, but a small company that develops experimental crystals appears to have its own crystal ball. Scientific Materials Corporation (SMC) in Bozeman, MT has been in the business of growing crystals since the 1980s. Since crystal development actually leads the device development by roughly seven years, the company has to see the destinations for their crystals far in advance. SMC's crystals are used in numerous areas of research and development to create new high-performance solid-state devices in the field of opto-electronics.

Why locate a crystal-growing company in Montana? The climate happens to be ideal. Crystal growth is the art of stability. According to Ralph Hutcheson, who founded the company, "what you're

trying to create is an atmosphere around your pot that is extremely stable, that has no outside interference, and you just let the thing essentially cook. You want Mother Nature to work with you, not against you." During the growing process, it is much easier to work with cold temperatures than hot temperatures.

Early in the company's history, Hutcheson attended a presentation where he heard a NASA expert talk about the need for lasers in space. As he sat in the audience, he thought, "I can do that." And he did. With funding from NASA Langley Research Center through a Small Business Innovation Research (SBIR) contract, the firm developed crystal

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Crystals developed for NASA Langley Research Center.

WebTurbine Impacts Learning

In today's interconnected world, collaboration and communication has become an integral part of one's daily life, be it in work or play. Students can no longer spend their days in isolated classroom "islands" and be well prepared to go home or on to future professions in which networked interactions are the norm.

There is an important difference between broadcast communications like radio and television, and networked communications like the Internet. The key difference is who is enabled to produce things of value that others consume. On the Internet, everyone can be a producer of value.

Networked interaction in the classroom or laboratory environment enables students to explore, ask questions and find answers. Enabling the student to be engaged in the pursuit of knowledge, free from the constraints of geographical location, is a strategy that helps us prepare the next generation of scientists and engineers. This use of networks for distance learning in its various forms is sometimes called telepresence.

The Internet today, however, is mostly a medium for essentially one-way communication from large, central publishers to relatively passive information consumers. We tend to mimic the broadcast communication model when we "surf" the Web to consume content. What is lacking is the means for convenient and effective information publication from the "edge" of the Internet where, for example, individual students, teachers and researchers are the producers and consumers. If the Web were to provide easy-to-use, bidirectional content sharing, then schools and students, typically limited in resources, would gain

access to the Web as a productive medium to contribute content, not just passively browse.

NASA Dryden Flight Research Center's pioneering work with Ring Buffered Network Bus (RBNB) technology, and now RBNB/WebTurbine, bridges this gap. Starting with the needs of real-time engineering test data distribution, a high-performance system has been built for enabling distributed collaboration, where engineers and scientists can share live, timely data. Adapted to the standards of Web-style communication, the resulting WebTurbine technology is accessible via simple and standard drag-and-drop files and Web browsers. Students and researchers can share a distributed information space of live, interactive data using familiar desktop interfaces and Web-enabled devices.

Thus, educators and students can become Web publishers of information that includes live, always-changing content using the limited resources available to them. Sharing this content amongst themselves, remote peers at other schools and/or becoming directly involved with NASA and its partners becomes part of the daily curriculum. The student becomes a contributor and partner, and, in doing so, gains the perspective and motivation to become an active participant in the quest for knowledge.

The RBNB core technology was developed by Creare, Inc. under a Phase II SBIR contract with NASA Dryden Flight Research Center. Efforts to enable telepresence and distance-learning applications also were funded by Dryden, but under a subsequent Phase III contract. □

For more information, contact Larry Freuding at NASA Dryden Flight Research Center, ☎ 661/276-3542, ✉ Lawrence.C.Freuding@nasa.gov. Please mention you read about it in **Innovation**.

SBIR

Continued from page 17

Radiation protection also is required for the Mars Rovers' electronics. Mars does not have the magnetic field and thick atmosphere like Earth's, which shields against high-energy radiation. A single event latch-up incident could mean the loss of data being collected by a science exploration rover. Maxwell Electronics has supplied A to D converters for the 2003 Mars Rovers that are single-event latch-up protected. This technology ensures the survivability of the rovers'

communication system in Mars' harsh radiation environment.

Maxwell Technologies is an excellent example of how NASA-sponsored research and development through the SBIR Program has enabled leading-edge space missions to achieve their objectives using cost-effective radiation-mitigation technologies. □

For more information, contact Byron Jackson of the JPL SBIR Program Office at ☎ 818/354-1246, ✉ Byron.L.Jackson@jpl.nasa.gov. Please mention you read about it in **Innovation**.

Seeing

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samples used as opto-electronic components in space-based lasers.

In 1990, a resurgence in the field of solid-state laser technology occurred, as people realized that lasers could be solutions for many approaching technology needs. “In the last 10 years, solid-state lasers have been moving from infancy to adolescence, as far as their applications are concerned. Not at adulthood yet, but slowly getting there,” says Hutcheson.

Langley Research Center was part of that resurgence, particularly in the area of remote-sensing applications for the space-based lasers, such as ozone and water vapor measurements. Because Scientific Materials had been looking ahead, they were ready. There was also a renewed focus on high-energy programs, growth in military applications such as target identification and target illumination, and an explosion in the use of medical lasers for surgery and treatment. All of these have pushed the technology development to new and higher levels.

Using that “crystal ball” to see the future needs for their crystals, SMC knew that two things had to happen: their quality had to be improved, and the prices had to become lower. The company has done both.

The net result is what Hutcheson calls the “Experimental Crystals Supermarket” at Scientific Materials. For any study requiring a crystal sample, there are numerous concentration variations of the required samples for the experiments—as many as 20–40 samples at far lower costs than 10 years ago. This has had tremendous benefits for the research community.

Keith E. Murray, a researcher in the Laser and Electro-Optics Branch at Langley, wanted to develop a

two-wavelength laser system for dental and medical applications. However, he had a very limited budget and needed to have the best candidate materials for true proof of principle demonstrations. Scientific Materials took an interest in Murray’s project and provided his required crystals at a fraction of what they might have otherwise cost.

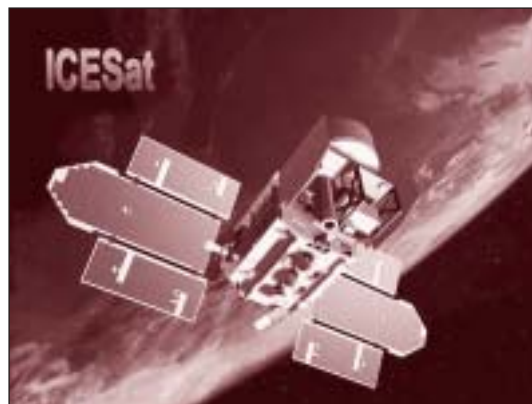
SMC works closely with Montana State University, also located in Bozeman. The firm is able to tap into the university intellectual community as they develop new products, and, at the same time, provide the professors and students with quality crystals for university research. Hutcheson considers the relationship to be a win-win situation. “The university found in the process of doing this, it actually broadened their education capabilities, and they brought a whole new level of activities to the students.”

Today, the company is recognized worldwide for its fine, high-quality crystal samples. Their largest commercial product is the result of their research efforts under the SBIR program with Langley—the crystal named Nd:YAG. Because of the intense beam it helps to produce in lasers, Nd:YAG is the workhorse of these crystals and is used for all types of machining processes.

SMC developed laser media and switches that are in the Geoscience Laser Altimeter System (GLAS), the first laser-ranging (lidar) instrument for continuous global observations of Earth. From aboard the Ice Cloud and Elevation Satellite (ICESat) spacecraft, GLAS is making unique atmospheric observations, including measuring ice-sheet topography, cloud and atmospheric properties, and the height and thickness of radiatively important cloud layers needed for accurate short-term climate and weather prediction.

Other SMC crystal samples are being developed for several major projects, including a monoblock laser for US Army range finder applications, a chip for a memory processor that will be capable of reducing huge amounts of data and then collating it very rapidly, and high-energy optics for high-energy lasers.

While these and other projects are in development today, Scientific Materials Corporation continues to peer into that crystal ball to see what will be needed tomorrow. □



Artist Rendering of ICESat. Langley Research Center.

For more information, contact Robert L. Yang, Manager of the Small Business Partnership Team at NASA Langley Research Center, r.l.yang@larc.nasa.gov. Please mention you read about it in **Innovation**.

Software Technology Works for NASA

Over the last several years, software development and application activities driven by NASA's Enterprises have emerged as a growing source of technological innovation for NASA and the nation. Reflecting both the evolution of NASA R&D and the increased emphasis on managing software as a key technology asset, the reporting of new software technology developed for NASA has doubled since 1998. Software technology currently accounts for one-third of all new, NASA-sponsored technology reported to the Agency.

Inventorizing the hundreds of software programs and associated algorithms, models and methods resulting from NASA R&D is only the first step, however, in realizing the potential applications and value of NASA-sponsored software technology. To this end, NASA seeks to transfer, enhance and apply software technology in collaboration with commercial firms and research institutions in ways that aid NASA mission programs and enable industrial use and commercial development. For example, the recent licensing of the Quantitative Risk Assessment System (QRAS) software, which was developed by the University of Maryland and NASA, bolsters the capabilities of a small US firm serving a worldwide market and provides for NASA's use of the commercially enhanced version of the software.

As in the case of QRAS, NASA recognizes that technological innovation—putting technology to work—requires world-class R&D and the skillful transfer and application of resulting technology in ways that yield performance improvements and other competitive advantages. Innovation further depends upon entrepreneurship and a combination of business and technical factors, including the sourcing of private capital, that are key to realizing

the potential of new technology. Thus, staying in touch with business, market and investment conditions shaping the development and use of new technology is a key aspect of the Agency's efforts to foster technological innovation in partnership with industry. To this end, a broad review of the software marketplace was conducted to assess opportunity areas for the transfer and collaborative development of software technology (see "Software Spotlight," *Aerospace Technology Innovation*, Volume 11, No. 2, Summer 2003).

More recently, two NASA Enterprises—Aerospace Technology and Biological and Physical Research—

NASA recognizes that technological innovation—putting technology to work—requires world-class R&D and the skillful transfer and application of resulting technology in ways that yield performance improvements and other competitive advantages.

joined together to sponsor the 2003 conference of the National Association of Seed and Venture Funds (NASVF) held November 2–4 in Baltimore, MD. Two NASA pioneering software technologies were examined during this conference: the Hilbert-Huan Transform (HHT) and the Embedded Web Technology (EWT). The HHT provides an efficient, adaptive and user-friendly method for analyzing data from physical signals. In turn, the EWT enables real-time remote control and monitoring of embedded systems via a standard Web browser.

As shown by QRAS, HHT, EWT and other software technologies, the cutting-edge research and technology undertaken for NASA's mission programs offer a wealth of opportunities for the nation's economic growth, competitiveness and quality of life. We invite you to explore these opportunities and partner with NASA to make innovation happen. □

To learn more, go to <http://www.nctn.hq.nasa.gov> or contact Jonathan Root, NASA Headquarters, ☎ 202/358-1845. Please mention you read about it in *Innovation*.

Technology Opportunity Showcase

Technology Opportunity Showcase highlights some unique technologies that NASA has developed and that we believe have strong potential for commercial application. While the descriptions provided here are brief, they should provide enough information to communicate the potential applications of the technology. For more detailed information, contact the person listed. Please mention that you read about it in **Innovation**.

Nanotechnology Vision Chip

NASA seeks to license or codevelop its Nanotechnology Vision Chip, a unique technology for stimulating retinal neural cells using an array of carbon nanotubes (CNTs). Developed at NASA Ames Research Center, in conjunction with Stanford University School of Medicine, the Vision Chip is designed to restore vision in patients suffering from age-related macular degeneration, the number-one cause of blindness in the elderly. Other potential applications include traumatic eye damage and ophthalmologic research.

The Vision Chip consists of an array of electrically conductive CNT towers grown directly on the surface of a silicon chip. Each CNT tower in the array is connected to its own electrical circuit, so that electrical signals generated by the pixels of a light detector (such as a charge-coupled device (CCD) chip, worn by the patient) can be transmitted to the CNT towers. For the intended application, thousands of CNT towers are closely spaced in an array, to match the spacing of the neurons within the retina.

The device is designed for implantation into the retina, so that the CNT towers come in direct contact with the retinal neurons. Electrical signals generated by a CCD camera are delivered to the implanted device via telemetry. Prototypes have used towers that are 100 microns in diameter and approximately 150 microns tall. Small chips (50–150 microns tall) with arrays of towers spaced 10–25 microns apart are under development. Optimization of dimensions and spacing serves to maximize “cross talk” within the retinal layer, producing a sharper image for the patient.

In an alternate version of this technology, the CNT towers may be implanted only partway into the retina and coated with special growth factors to stimulate growth of retinal neurons toward the CNT towers. CNTs provide a highly biocompatible surface and may be doped with a variety of growth factors and cytokines to stimulate attachment of neural cells to the CNT towers. With this enhancement, only minimal penetration of the retinal tissue (25–50 microns) may be needed to promote neural cell/CNT tower connections and restore vision.

Short-term in vitro tests of the implant materials with retinal ganglion cells suggest excellent biocompatibility. Additional in vitro and in vivo tests are underway.

The benefits of the technology are numerous. It can allow for vision restoration in cases of macular degener-

ation. Small, nano-sized components allow for an image resolution density similar to that of native retinal photoreceptors. □

For more information, contact Lisa Williams, NASA Ames Research Center, at ☎ 650/604-2954, ✉ liwilliams@mail.arc.nasa.gov. Please mention you read about it in **Innovation**.

Lithium Polymer Batteries

NASA seeks to license the technology entitled Lithium Polymer Batteries, a rod-coil polymer that combines high ionic conductivity with dimensional stability.

Developed at NASA Glenn Research Center, Lithium Polymer Batteries offer cost and performance advantages over other types of batteries. Today's solid polymer batteries can only operate at elevated temperatures because the solid polymer electrolytes have unacceptable ionic conductivities below 60 degrees Celsius. Below this temperature, higher conductivity can be achieved by adding solvent to the polymer electrolyte, but the solvent compromises the electrolyte's dimensional and thermal stability. The resulting gel system requires elaborate packaging, and flammability is a concern.

Scientists at the NASA Glenn Research Center have developed an electrolyte material that solves these problems. This new material comprises a series of rod-coil block copolymers in which rigid polyimide rods alternate with very flexible coils of polyethylene oxide (PEO). Because the rods and coils are incompatible, the blocks tend to phase separate. The result is a polymer with nanoscale channels of ionically conducting PEO alternating with concentrations of the rigid rods. The rod regions form the mechanical support for the conducting PEO coils, resulting in a material with both good conductivity and mechanical integrity.

This technology will enable solid polymer lithium batteries to operate at room temperature conditions. Solid polymer lithium batteries offer many advantages over other battery designs, including low cost, lightweight, high specific energy, improved safety and flexible design. Commercial applications could include an electrolyte for solid polymer lithium batteries and proton exchange membranes for fuel cells. □

For more information, contact Laurel Stauber, NASA Glenn Research Center, ☎ 216/433-2820, ✉ Laurel.J.Stauber@nasa.gov. Please mention you read about it in **Innovation**.

NASA Technology Transfer Network Directory



NASA ONLINE

Go to the NASA Commercial Technology Network (NCTN) on the World Wide Web at <http://nctn.hq.nasa.gov> to search NASA technology resources, find commercialization opportunities and learn about NASA's national network of programs, organizations and services dedicated to technology transfer and commercialization.

NASA Field Centers

Ames Research Center

Selected technological strengths are Information Technologies, Aerospace Systems, Autonomous Systems for Space Flight, Computational Fluid Dynamics and Aviation Operations.

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Dryden Flight Research Center

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Glenn Research Center

Selected technological strengths are Aeropropulsion, Communications, Energy Technology and High-Temperature Materials Research, Microgravity Science and Technology, and Instrumentation Control Systems.

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Goddard Space Flight Center

Selected technological strengths are Earth and Planetary Science Missions, LIDAR, Cryogenic Systems, Tracking, Telemetry, Command, Optics and Sensors/Detectors.

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Jet Propulsion Laboratory

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Johnson Space Center

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Kennedy Space Center

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Langley Research Center

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Marshall Space Flight Center

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NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint-sponsored research agreements and incubate small start-up companies with significant business promise.

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NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D agencies and to foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the RTTC nearest you, call 800/642-2872.

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Events

World's Best Technologies 2004 (WBT04) Showcase

Seventy-five exhibitors will be selected to showcase their emerging technologies. While all those selected will receive exhibit space and the opportunity to make a brief presentation, the top 25 exhibitors will be invited to make

12-minute presentations about their technologies. This event will take place March 21–23, 2004 at the Wyndham Arlington in Arlington, TX. For more information regarding registration or sponsorship, contact Paul Huleatt at 602/795-8825 or phuleatt@worldsbesttechnologies.com

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